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the variations in the sun-spot data correspond exactly to those relating to the element under examination, we shall be compelled to admit some sort of a causal connection; and that, even if the nature of the connection is inscrutable.

Numerous such comparisons have been made during the past twenty-five years. So far the results must be pronounced indecisive, except as regards the effects of solar disturbances upon terrestrial magnetism. Here all the investigations agree in showing an intimate connection, the mechanism of which is, however, still unknown. When sun-spots are numerous and active, we always have magnetic storms upon the earth, manifested by the

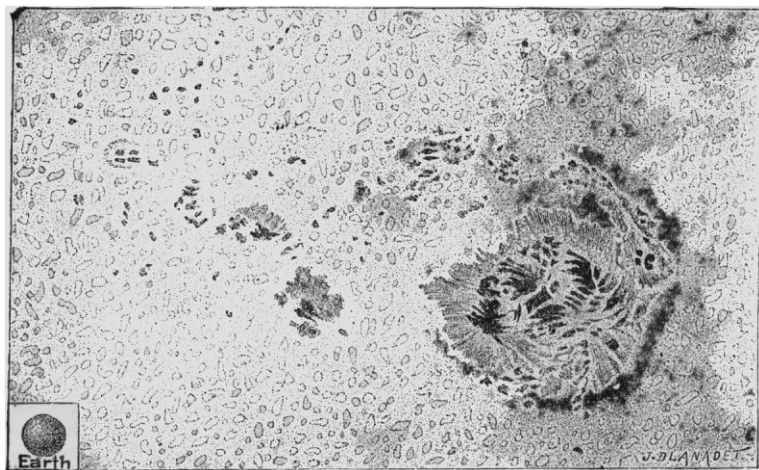
of Prague, from all the observations he could collect in Germany up to 1870, obtained a purely negative result. Discrepancies of the same sort appear in the results of other investigators, with reference to the rainfall and the height of rivers in different parts of the earth; though, on the whole, they seem to show a slight increase in the rainfall (one or two per cent) at or near the time of spot-maximum.

It is to be remarked, however, that these discrepancies and contradictions by no means disprove the reality of sun-spot influence. It is quite possible, and even likely, as Dr. Gould and others have pointed out, that slight changes in the sun's

radiation might be felt mainly by their effect in disturbing atmospheric currents, and so altering the distribution of heat and moisture, rather than by any general effect. In this case, the effects in neighboring regions would evidently be exactly opposite in character.

As matters stand, it is clear, in the first place, that a much longer period of observations will be needed to settle the question decisively as to the reality of sun-spot influence; and, in the next place, that, if the influence is real, it is only slight, and so masked by

other effects as to be difficult of detection. There can be no reasonable expectation that the ordinary variations in the state of the solar surface will prove to be dominant, or even very important, in terrestrial meteorology, or in human conditions that depend upon climate and the weather.



SUN-SPOT AS SEEN JULY 25, 1883.

aurora-borealis and by strong disturbance of our compass-needles.

The investigations in regard to other elements have, as Professor Langley says, "nearly every one brought out some result which might be plausible if it stood alone, but which is apt to be contradicted by the others." For instance: Dr. Gould in South America, and Mr. Stone at the Cape of Good Hope, think they have detected a slight lowering of temperature, amounting to one or two degrees, at the time of sun-spot maximum; while at Edinburgh, Smyth reaches a similar conclusion, except that the minimum temperature follows the sun-spot maximum at an interval of about two years. On the other hand, Chambers, from twenty-eight years' observations in India, finds a *rise of temperature* coinciding with the sun-spot maximum; and, in opposition to all the others, Jelinek

THE INSECTS OF THE YEAR.

"Fairy bands
Sailing, 'mid the golden air,
In skiffs of yielding gossamer."

HOGG.

THE seasonal appearance of insects varies. Some species are found during several months, others at all times of the year; some vary in date of appearance with the earliness or lateness of the

season, while others appear quite punctually, regardless of the season. In the same locality the peach will blossom one year in February, another not till May; and there is similar variation in the first appearance of spring insects. The irregularity lessens, however, as the growing season advances. July is more uniform than April. From Boston to Enterprise, Fla., one may travel in a couple of days in January from ice-bound midwinter to summer temperature, and, with the progress southward, activity in both plant and insect life increases. In a country so vast that it represents sub-boreal and sub-tropical temperatures at one and the same time, it were eminently improper to speak of the appearance of an insect without specifying the latitude. The midwinter difference between Maine and Florida, however, is not the difference between dead of winter, and height of summer; because there is, even in the subtropical sections, a winter or hibernating period when insect-life is comparatively at a stand-still, or dormant.

For calendar purposes the country may be divided into northern, middle, and southern; and, where not otherwise stated, the following index to the first appearance of some of our more conspicuous insects will have reference to some middle latitude. St. Louis is a very good point, being central between the Atlantic and the Rocky Mountains, our northern boundary and the Gulf; while Washington is another, lying well between our northernmost and southernmost borders. Between the Gulf and Lake Superior there is a difference in earliness of spring forms of nearly two months, or of four to five days with each degree of latitude, as the history of the Rocky-Mountain locust (*Caloptenus spretus*) and of the army-worm (*Leucania unipuncta*) shows. This difference, as already indicated, diminishes for summer forms. Development quickens in adaptation to the shorter northern season; and a widely distributed species, that does not mature till August in Missouri, or even Texas, may appear but a few days later in Minnesota.

January.—Hushed in a frosty cradle, as most lower life is at this season, the snow-fleas (genus *Podura*)—little, black, springing creatures not more than one-twentieth of an inch in length—may nevertheless be seen during a mild spell, abounding on the snow, even in the more northern states. To the southward, whenever the temperature is above freezing-point, the farmer will start from his corn-shocks various hibernating bugs, as the chinch-bug (*Blissus leucopterus*) and the tarnished plant-bug

(*Lygus lineolaris*); while the housekeeper may be alarmed by the buzzing of the paper-wasps (genus *Polistes*), and particularly *Polistes metricus* and *P. annularis*. Still farther south many butterflies, especially the yellows (genus *Colias*) and the whites (genus *Pieris*), so common everywhere later in the season, may be observed.

February.—In average or normal years the insect-life of this month resembles that of the preceding. On mild days swarms of small gnats (*Chironomidae*) dance in the air near still waters, while near larger streams small sombre-colored Neuroptera (*Perlidae*) will often fly. The wingless female of the spring canker-worm moth (*Paleacrita vernata*) ascends the trunks of apple and elm trees, while the male, with ample wings, flits about her. In the extreme north the remarkable wingless and spider-like dipteran (*Chionea valga*) and the equally remarkable neuropteran (*Boreus nivoriundus*), also wingless in the female sex, may be seen upon the snow; while in the south our heaviest-bodied butterfly (*Megathymus yuccae*) and our most graceful species (*Heliconia charitonia*) are conspicuous,—the one darting swiftly among the yuccas, the other slowly sailing through the dense underbrush of the shady hammocks.

March.—Insect activity now rapidly increases. With the thawing of the ice in ponds and ditches, the water-beetles (*Dytiscidae*) appear, while in the woods many species of ants (*Formica*) make their way from their subterranean abodes. Many pine-boring beetles (*Buprestidae* and *Scolytidae*) are seen, and a small dung-beetle (*Aphodius inquinatus*) flies in countless numbers. The velvety brown larva of *Telephorus* will follow the melting snow, the brown and black hedge-hog caterpillar (*Arctia isabella*) will scamper across a sun-warmed path, and the dipterous *Bibio* larvae will be found in masses under decaying leaves in the garden. Of butterflies, the mourning-cloak (*Vanessa antiopa*), with its beautiful purple-brown and cream-margined wings, somewhat the worse for wear, is conspicuous; and, of moths, the cotton-worm moth (*Aletia xyliana*), the army-worm moth (*Leucania unipuncta*), and *Platyhyphenia scabra*, are noteworthy in the south.

April.—The first flowers of spring, and especially the catkins of willows and poplars, teem with insects of many orders, but especially the Hymenoptera of the genera *Andrena*, *Halictus*, *Melissodes*, and *Nomada*, which have issued from their underground nests. The honey-bee (*Apis mellifica*), the carpenter-bee (*Xylocopa virginica*), and the bumble-

bee (*Bombus*) are conspicuous. Among Coleoptera, the blister-beetles (*Meloidae*) and the tiger-beetles (*Cicindelidae*) are noticeable; and the painted clytus (*Cyllene pictus*), with its black-and-yellow banded coat, will be common in houses where hickory-wood is used in the fires. Among Lepidoptera, the 'blues' (*Lycaenidae*), the monarch or milkweed butterfly (*Danais archippus*), the Graptas, and *Eudamus bathyllus* will be seen. Among Orthoptera, the *Acridium americanum* and *Oedipoda phoenicoptera* will be noticeable among wintering forms on account of their large size.

May. — In this month the hibernated legion is warmed to new life, and the number of species occurring is too great to warrant special indication. The large tiger swallow-tail (*Papilio turnus*) darts swiftly about, while a lot of humbler butterflies are seen. Those gigantic beauties of the night, the *Cecropia* moth (*Platysamia cecropia*) and the *Polyphemus* moth (*Telea polyphemus*), are seen hanging listless as they just issue from their cocoons, or pass bat-like at dusk overhead. Some of the hawk-moths (*Sphingidae*) already begin to hover at twilight, humming-bird fashion, over honeysuckle and other honey-yielding flowers. The carpenter moth (*Xyleutes robiniae*) will be found early in the morning, resting on the trunk of the black locust, from which the empty pupal exuvium sticks out as an index. A host of Hymenoptera make their advent; and noticeably the gigantic saw-fly (*Cimbex americana*) will be found ovipositing in willow leaves, and the pigeon *Tremex* (*Tremex columba*) in old maple trunks. The buffalo-gnat (*Simulium*) swarms in the lower Mississippi country to the injury of all kinds of stock. The fruit-grower finds the plum curculio (*Conotrachelus nenuphar*) making its dreaded crescent-mark on his fruit, and the canker-worms blighting his apple-trees. The house-keeper observes with dread the various clothes-moths (*Tinea*) and the carpet-beetle (*Anthrenus scrophulariae*). But the latter part of the month is chiefly characterized, first, by the hosts of delicate May-flies (*Ephemeridae*) which issue from our rivers in the sub-imago state, and, attracted to the light, crowd on windows and around lamps; second, by the swarms of more robust May-beetles (*Lachnosterna fusca*), which begin to defoliate oak-groves and poplar-trees.

June. — During this leafy month, when nature's pulses beat most strongly, insect-life is at its acme. The army-worm marches through meadow and grain-field, and a host of destructive species gather force and spread dismay. The woods and meadows

abound in gaudy butterflies, and multiform caterpillars feed voraciously. The commoner firefly (*Photinus pyralis*) rises slowly from the moist ground at eve, and intermits its soft, glowing light. But the month is chiefly characterized by the appearance of that singular periodical, or seventeen-year Cicada (*Cicada septendecim*), with its *tredecim*, or thirteen-year race. The woods rattle with its hoarse beat about the first of the month, and broods appear in some locality or other nearly every year. The present year (1885) is a memorable one; for a very extensive seventeen-year brood, which appeared last in 1868, and has been fully recorded every seventeen years since 1715, may be looked for on Long Island and in Monroe county, N.Y., in south-eastern Massachusetts, in parts of Vermont, Pennsylvania, Delaware, Maryland, Virginia, District of Columbia, in north-western Ohio, in south-eastern Michigan, in Indiana, and in Kentucky.

July. — With the great heat of July there is less variety of insect-life than in June, and the month is chiefly notable for the tormentors. Horse-flies (*Tabanidae*) interfere with the ploughman's work, mosquitoes swarm to such an extent in the north-west as to render travel for both man and beast positively dangerous, while the bot-flies (*Oestridae*) attack horses, cattle, and sheep. The nests of the tent-caterpillar (*Clisiocampa americana*) and of the fall web-worm (*Hyphantria textor*) disfigure orchard and forest, and the tumble-dungs (*Canthon*) assiduously roll their balls of dung. The harsh rattle of the dog-day harvest-fly (*Cicada canicularis*) is also first heard.

August. — In this month the fossorial Hymenoptera most abound, and the numerous locusts (*Acrididae*) begin to get their wings, and reach their greatest destructiveness. The katydids and the tree-crickets also become full-fledged, and join the other insect stridulators which fill the late summer and autumn nights with sound. The cotton-worm does its greatest mischief in the south, and the chinch-bug leaves the wheat-fields for the maize. Many true bugs (*Hemiptera*) get their wings, among which the wheel-bug (*Reduvius novenarius*) is conspicuous. The dragon-flies (*Libellulidae*) are more numerous, and the mantis (*Mantis carolina*) and the walking-stick (*Diapheromera femorata*) acquire full growth, and are more noticeable than formerly.

September. — Many of the insects of the preceding month are still more noticeable in this, while few new ones appear. The blister-beetles and a vast number of smaller Hymenoptera abound on the flowers of the golden-rod; and most species are

busy providing for their issue, or preparing for winter quarters.

October.—This is the month when spiders of all kinds are most noticeable, their gossamer threads glistening high up in the air, or their webs disfiguring shrubs and buildings. Immigrant plant-lice come on the wing to store away the winter egg on congenial trees; and the other insects most noticeable are those which hibernate, and are getting ready to do so. The buck moth (*Hemileuca maia*) flies quietly, with its delicate crape-like wings, among the dropping leaves of the forest, and is the species most peculiar to the month.

November.—In this month most insects are hushed in death or torpor; but the fall canker-worm moths will rise from the ground after a severe frost, and many hibernating Hymenoptera and Coleoptera will take an airing when the weather is mild. The cluster-fly (*Pollenia rudis*) holds out against the cold much longer than the house-fly, which it so much resembles.

December.—Nothing peculiar marks this month; but most of the species mentioned for both November and January may be seen in December, when the temperature and circumstances favor.

WEATHER FORECASTS.

*"Another storm brewing; I hear it
Sing i' the wind."*

SHAKESPEARE.

THE methods by which weather forecasts are made are based almost wholly upon facts of observation rather than upon established deductions of science. This is unavoidable, because atmospheric movements are very complicated, and because the science of meteorology is not yet sufficiently advanced to satisfactorily explain them in the detail necessary for successful forecasting.

The leading fact upon which predictions depend is that atmospheric conditions advance in a direction generally easterly. The motion may vary in velocity, but in direction is usually between north-east and south-east, rarely towards any other point of the compass. During this advance, changes in condition may occur; and it is necessary to foresee the character of these changes, as well as the direction, and rate of motion. The indications of the barometer are the chief aid in understanding the weather conditions themselves, and the changes which may be expected. At any given moment there exist, in the territory occupied

by the United States, differences in the atmospheric pressure which may amount to two inches in the height of the barometer. Usually there are one or more areas of pressure above the average, and one or more below the average, the pressures at intermediate points lying between the highest and lowest values. Each of these areas of high and of low pressure is accompanied by its peculiar conditions, and is moving towards the Atlantic coast with varying velocity. Thus the low area, if its centre is more than two or three tenths of an inch below the average pressure, is accompanied by clouds, and rain or snow, and forms a storm. The area of high pressure is usually attended by clear skies; and the radiation of solar heat to the earth during the day, or from the earth at night, is unchecked by clouds: consequently in summer, when the days are long, the temperatures which accompany an area of high pressure are above the average; while in winter, when the nights are long, low temperatures are found with high pressures. Many similar facts have been learned from the study of meteorological observations, upon which dependence is placed in weather-predicting.

Under the auspices of the U.S. signal-service, observations are made three times each day at a hundred and twenty-nine stations suitably located. Each of these observations is made at the same moment (seven A.M., three P.M., and eleven P.M., Washington time), and includes determinations of the atmospheric pressure, the temperature and humidity of the air, the direction and velocity of the wind, the kinds and motion of clouds, and other meteorological data. The results are at once telegraphed to the central office, and maps formed which show graphically the conditions at the moment of observation, and the changes which have occurred in the past few hours. From these maps a detailed prediction is made for the twenty-four hours following, based upon the conditions which exist at the time, the changes which have occurred, and the changes which, former experience shows, usually follow similar conditions.

The weather prediction thus assumes that coming changes will agree with the changes noted in former times under like circumstances. This is true on the average; but, whenever exceptions occur, the prediction fails. Increased skill in predicting depends upon increased skill in anticipating these exceptional cases. At the present time the government predictions are verified in eight cases out of ten. Reliable forecasts cannot be made for a period longer than twenty-four hours,